Gilhousen, et al., U.S. Pat. No. 5,109,390, disclose a spread spectrum receiver capable of differentiating multiple pilot signals and selecting the signal of greatest strength. The transmitting base stations are synchronized to operate from a master clock. Receiving mobile stations can maintain timing accuracy sufficient to demodulate received messages from all base stations by monitoring the pilot channel of any single base station. However, Gilhousen et al. do not disclose a method of conveniently receiving communications from asynchronously transmitting base stations.

Ling, U.S. Pat. No. 5,329,547 discloses a method of inserting reference symbols into a stream of spread spectrum data symbols. The reference symbols help generate a channel estimate. That is, the insertion of predetermined data, or reference symbols into the data stream helps eliminate phase ambiguity in demodulating unknown data symbols. However, Ling does not disclose a method of synchronizing the timing between a plurality of received channels.

It would be advantageous if a W-CDMA receiver were developed to acquire the channels of a first asynchronously transmitting base station independent of the transmissions of other base stations. It would also be advantageous if the receiver could direct a plurality of base stations to synchronize transmissions to take advantage of the diversity provided by receiving from several base stations.

It would be advantageous if the base station transmitted broadcast, or perch channel could be used by a mobile station to maintain timing for all channels received from that base station.

It would be advantageous if the amount of channel information present in the structure of a receiver multichannel CDMA waveform was maximally utilized.

It would be advantageous if the broadcast channel in a W-CDMA system, generally having more transmitted power than the traffic channels and a greater number of reference symbols, could be used by a mobile station to demodulate the traffic channel.

It would be advantageous if the channel estimates derived from the broadcast channel could be applied to all the received channels of the same transmission path. In this manner, the channel estimate need be performed only once.

Accordingly, a method of receiving communications in a CDMA communication system, including a plurality of base stations asynchronously transmitting information to a plurality of mobile stations, is provided. The communications from a base station to a mobile station are formatted in a plurality of channels. Due to multipath, these communications are propagated along at least one transmission path, with a corresponding path delay. Each of these communications can be considered a family of related channels, so that families of channels propagate along the same transmission path. A method for each mobile station to receive base station communications comprises the steps of:

a) for each base station from which a communication is received, identifying at least one transmission path between a base station and the mobile station. Typically a mobile station is able to identify a base station communication along several transmission paths; and

b) in response to the transmission paths identified in Step a), despreading at least one received communication. That is, in an asynchronous system of transmissions, the mobile station is able to recover the data symbols in the communication in response to timing information recovered from locking the receiver onto any one of the multipathed base station transmissions.

Each base station transmission includes a broadcast channel message with a plurality of predetermined time multiplexed symbols, including a predetermined special timing symbol known to each mobile station. Step a) includes, for each transmission path identified in Step a), despreading the special timing symbol, whereby broadcast channel multiplex timing information is derived. Further steps include:

a_1) in response to special timing symbol despread in Step a), calculating channel timing information for each transmission path detected in Step a); and

in which Step b) includes despreading received communications in response to the channel timing information calculated in Step a_1).

The broadcast channel message includes time multiplexed data symbols, and predetermined time multiplexed reference symbols known to the mobile station. Step b) includes despreading the broadcast channel data and reference symbols. Initially, the channel timing is found by despreading the special timing signal in Step a_1). The timing is improved by despreading the reference symbols in Step b).

Each base station transmits at least one traffic channel message, unique to each mobile station. The traffic channel has a plurality of time multiplexed data symbols. Step b) includes despreading the traffic channel data symbols. Since the reference and data symbols for both the traffic and broadcast channels are modulated before transmission, the method of the present invention includes the further steps, following Step b), of:

c) in response to the broadcast channel reference symbols despread in Step b), demodulating the broadcast channel reference symbols to provide transmission path weights and phase shift information;

d) in response to the weights and phase shifts provided is during the demodulation of the broadcast channel reference symbols, estimating weights and phase shifts to apply to data symbols; and

e) in response to estimations made in Step d), demodulating the broadcast and traffic channel data symbols.

Each traffic channel message includes predetermined time multiplexed reference symbols known to each mobile station, which are modulated before transmission. In some aspects of the invention, Step b) includes despreading the traffic channel reference symbols. Then, the traffic channel reference symbols are demodulated to provide transmission path weights and phase shift information. In addition, the weights and phase shifts provided from the demodulation of the traffic channel reference symbols are used to estimate weights and phase shifts to apply to the demodulation of the traffic channel data symbols.

Ultimately, the broadcast channel data symbols demodulated for each transmission path are combined in a RAKE receiver to improve the signal to noise ratio of a received message. This process occurs by combining the received transmissions of each base station.

A mobile station receiver to accept base station communications is provided. The receiver comprises at least a first filter matched to despread the broadcast channel special timing symbol. The first matched filter accepts the broadcast channel special timing symbol received for each transmission path from a communicating base station, and provides the despread special timing symbol for each transmission path.

The receiver also comprises a timing and code management circuit connected to the first matched filter output to accept despread special timing symbols for each transmission path. The timing and code management circuit provides the despread broadcast channel special timing symbol for each transmission path, and a second output provides the broadcast channel multiplex timing information and base station identification for each transmission path.